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Declarations under Rule 4.17:

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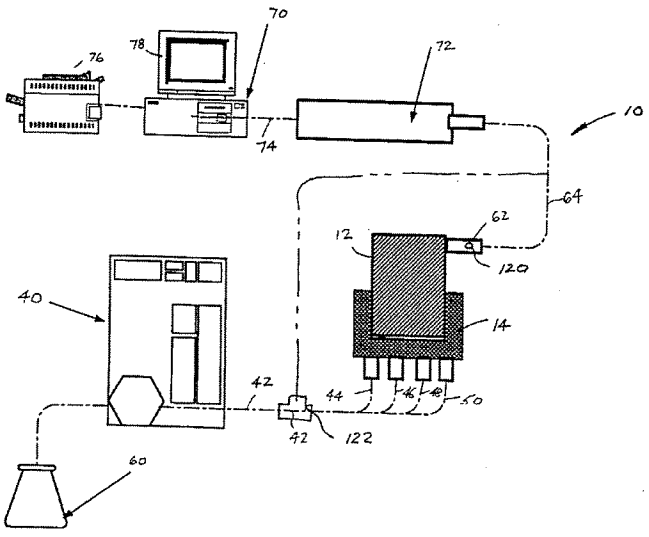
(54) Title: FLOWABILITY TEST OF INK IN INKJET CARTRIDGES



(57) Abstract: An apparatus (10) and method for testing ink flowability includes a pump (40) that communicates with nozzle sets (22, 24, 26, 28) of a printhead (19) that receives ink from a cartridge (12). Interchangeable masks (90) selectively cover portions of the printhead so that only selected nozzles communicate with the pump. Data is collected from residual pressure measured in the cartridge and is indicative of link flowability. Applying a vacuum to the printhead simulates printing. Covering the printhead with a mask so that only selected nozzles are exposed to the vacuum allows test data to be collected based on a particular ink type.

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MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

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APPARATUS TO TEST THE FLOWABILITY OF INK AND POROUS MEMBERS BY NOZZLE GROUP OR COLOR IN INK JET CARTRIDGES

Cross-Reference to Related Applications

[0001] This application claims priority from provisional application Serial No. 60/239,089, filed October 06, 2000.

Background of the Invention

[0002] This invention generally relates to the ink jet printing art, and more particularly to test equipment that evaluates the flow of ink from an ink cartridge printhead.

[0003] There is a demand in the aftermarket for compatible ink jet cartridges that meet or exceed original equipment manufacturer (OEM) standards. As a part of developing the compatible cartridges, it is necessary to benchmark structural and operational characteristics of the OEM cartridge. Once this information is obtained, a set of design parameters are developed for the compatible cartridge, i.e., type of ink absorbing member or foam, type of ink, etc. It will also be appreciated that various types of ink, various colors of ink, the type of foam, nozzle configurations, etc., all have an impact on the ink flow rate. As will be appreciated, it is important that the compatible cartridge closely match the flow characteristics of the OEM cartridge so that the compatible cartridge is easily incorporated into a printer and provides the same quality as the OEM product.

[0004] The more information or data that can be gathered with regard to various ink bearing members, inks of varying viscosities, ink flow rates, and nozzle configurations allows greater flexibility and selection of more economic materials in a rapid manner. In the past, insufficient data was available which resulted in increased experimental testing of

various cartridge designs. This reduces quality and slows development of compatible cartridges. A significant advance could be obtained in development time, reliability, and quality control if the design is developed from the beginning with more accurate and complete data.

Summary of the Invention

[0005] An apparatus for testing ink flowability includes a test cartridge that communicates with a printhead having a plurality of nozzles. A pump applies a vacuum on the nozzles that simulates printer flow rate through the printhead. A mask selectively covers a predetermined portion of the printhead so that only selected nozzles communicate with the pump, while a data collector monitors and collects data relating to ink flow through the selected nozzles.

[0006] The data collector includes a pressure transducer that receives residual pressure/vacuum data created by the displacement of fluid from the cartridge and conveys an electronic signal to a data processor indicative of flow rate.

[0007] Additional masks have openings at different locations to test ink flow through different nozzles of the printhead.

[0008] A preferred method of testing ink flowability from a printhead of an ink cartridge includes the steps of applying a vacuum to the printhead to simulate a printing operation, covering the printhead with a mask having an opening so that a selected first set of nozzles are exposed to the vacuum, and monitoring the pressure in the cartridge to collect test data indicative of ink flow through the first set of nozzles.

[0009] The apparatus and method provide a wide array of test data relating to an ink cartridge so that compatible cartridges closely simulating operation of an OEM cartridge can be developed.

[0010] The apparatus can be easily converted to test flowability of different ink colors or different ink viscosities.

[0011] Masking selected nozzles permits a quick and precise collection of data relative to different ink viscosities or colors.

[0012] Still other advantages and benefits of the invention will become apparent to those skilled in the art upon reading and understanding the following detailed description.

Brief Description of the Drawings

[0013] Figure 1 is a schematic representation of a test system.

[0014] Figure 2 is an exploded view of the ink set separated from the printhead carriage.

[0015] Figure 3 is a plan view of a nozzle plate.

[0016] Figures 4-7 are plan views of alternative seal masks.

[0017] Figure 8 is a perspective view of a seal mask being inserted into a clamp block.

[0018] Figure 9 is a schematic representation of a modified test system.

Detailed Description of the Preferred Embodiment and Method

[0019] A system 10 for testing ink flowability is generally illustrated in FIGURE 1. An ink jet cartridge 12 is received in a test stand 14. As more particularly illustrated in FIGURES 2 and 3, the test stand includes an ink jet printer nozzle carriage 16 and printhead 18 which includes a nozzle plate 20 having a series or sets of nozzles 22, 24, 26, and 28. For example, first nozzle set 22 is related to one color of ink, for example yellow ink. Likewise, the second, third, and fourth nozzle sets relate to cyan, magenta, and black ink

nozzles, respectively. Different colors and/or different openings of the nozzles can be used without departing from the principles of the present invention. A pump 40 communicates with the test stand and cartridge through passage 42. The passage separates into branch passages 44, 46, 48, and 50 for communication with the individual nozzle sets. Thus, if a greater or lesser number of nozzle sets are associated with a particular cartridge, then the corresponding number of branch passages may be altered.

[0020] The pump is a metering pump that applies a vacuum operating at the same flow rate as a conventional printer in which ink jet cartridges of this type are used. After the ink passes through the nozzles, the test stand 14, the branch passages, and the pump 40, it is collected in waste container 60.

[0021] The ink cartridge is modified to include a fitting or connector 62 that is associated with an opening in the cartridge, for example, by attaching the fitting to a conventional vent port of an ink cartridge. The fitting provides a sealed interconnection with passage 64 that leads to a data collector, shown here as including a conventional processor or computer 70. A pressure transducer 72 is include in the line 64 in order to convert the residual pressure that passes through the line from the cartridge, and provide data in a form useful for the data processor 70. The pressure transducer converts the sensed pressure in the cartridge into an electronic signal or data sent via line 74 to the processor. It will be appreciated that the flow path from the cartridge to the pressure/vacuum transducer 72 is air-tight and provides for an accurate sampling of the residual pressure within the cartridge created by the displacement of ink from the ink chamber. The residual pressure is indicative of ink flowability from the cartridge and thus the electronic signal

sent to the processor is collected, analyzed, etc. to develop operational information with regard to the cartridge and ink flowability. The printer 76 and display monitor 78 are also illustrated as being in operative communication with the processor as alternative means of displaying the data collected and processed by the computer.

[0022] With continued reference to FIGURE 1, and additional reference to FIGURES 2 and 3, it will be appreciated that the ink cartridge 12 is mounted in the printhead carriage 16 in a generally conventional manner. An ink outlet port 80 of the ink cartridge provides a supply of ink held in the cartridge to the printhead, and particularly supplies ink to the nozzle plate 20. In order to provide an accurate assessment of the flow rate of a particular type of ink, the system must be able to segregate the flow rates associated with a particular ink or color. To test the individual nozzle sets, one of a series or set of customized masks shown in FIGURES 4-7 are preferably used. For example, FIGURE 4 illustrates a mask 90 having an opening 92 that, when positioned over the nozzle plate, provides access to the first set of nozzles 22. Similarly, in FIGURE 5, the mask 90 includes an opening 94 that provides access to the second set of nozzles 24. Likewise, mask 90 in FIGURE 6 has an opening 96 that aligns with the nozzle set 26 in the nozzle plate, and opening 98 in the mask shown in FIGURE 7 is substantially enlarged to accommodate the fourth set of nozzles 28 that dispense black ink. Of course, different configurations of masks or openings could be used to selectively cover and provide access to selected nozzle sets or portions of nozzle sets as may be required for data acquisition.

[0023] As shown in FIGURE 8, a clamp block 100 includes a recess 102 dimensioned to receive a mask 90 therein. The

recess has a central opening or drain 104 that communicates with a drain or suction passage 106. The drain passage is in communication with one or more of the branch lines 44, 46, 48, or 50 of the test stand. In this manner, the drain or suction line 106 communicates with the pump and a vacuum is applied through opening 104 and through the opening in the particular mask placed in the recess. By sealingly clamping the cartridge to the mask, the remaining nozzle sets are covered and only those nozzles accessible through the mask opening are exposed to the vacuum applied by the pump. Residual pressure readings are then taken during testing and the associated data collected and analyzed by the processor 70 as noted above.

[0024] In operation, the method of testing the flowability includes the steps of applying a vacuum to a printhead to simulate printing. Covering the printhead with a mask 90 provides an opening 92, 94, 96, or 98 over a corresponding set of nozzles 22, 24, 26, or 28. Only one of the set of nozzles is exposed to the vacuum in this manner. Monitoring the residual pressure in the ink cartridge is provided via the fitting 62 that communicates with the pressure or vacuum transducer 72 so that ink removed from the cartridge is displaced from the cartridge cavity and provides a residual pressure or vacuum that is indicative of ink flowability. That pressure or vacuum is converted by the transducer 72 and the information collected, organized, and/or displayed in a conventional manner such as on the printer 76 or monitor 78.

[0025] As will be further appreciated from Figure 9, line 64 from the pressure transducer can be used to alternatively benchmark vent pressure and ink flowability. Particularly, by providing an opening 120 in the connector 62 and attaching the pressure transducer to the connector 62 via line 64, a reading of vent pressure is obtained to represent air flow through the

cartridge vent opening. By removing the line 64 from the connector 62 and attaching the line to a fitting, such as tee fitting 122, the fluid flow pressure of the ink through line 42 is then monitored by the pressure transducer.

[0026] The invention has been described with reference to the preferred embodiment and method. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations in so far as they come within the scope of the appended claims or the equivalents thereof.

Claims(s)

Having thus described the present invention, it is now claimed:

1. An apparatus for testing ink flowability, the apparatus comprising:

a cartridge having a printhead with a plurality of nozzles;

a pump communicating with the nozzles and applying a predetermined vacuum on the nozzles to simulate flow rate through the printhead;

a mask for selectively covering a predetermined portion of the printhead so that only selected nozzles communicate with the pump; and

a data collector evaluating flow through the selected nozzles;.

2. The apparatus of claim 1 further comprising a pressure transducer receiving pressure data from the cartridge and conveying electronic data to the data collector.

3. The apparatus of claim 1 further comprising a clamp block that receives the cartridge printhead.

4. The apparatus of claim 3 wherein the clamp block includes a recess that generally conforms to the printhead.

5. The apparatus of claim 4 wherein the mask is sealingly clamped to the printhead.

6. The apparatus of claim 1 further comprising additional masks having openings at different locations to test ink flow through different nozzles on the printhead.

7. A method of testing ink flowability from a printhead of an ink cartridge comprising the steps of:

applying a vacuum to the printhead to simulate printing;

covering the printhead with a first mask having an opening therethrough so that a selected first set of nozzles are exposed to the vacuum; and

monitoring residual pressure in the ink cartridge during the simulated printing in order to collect test data regarding flow of ink through the selected first set of nozzles.

8. The method of claim 7 wherein the covering step includes securing the printhead of the ink cartridge in a clamp block.

9. The method of claim 8 wherein the covering step includes sealingly engaging the printhead to the clamp block.

10. The method of claim 7 including the further step of substituting the first mask for a second mask having an opening at a different location so that a selected second set of nozzles are exposed to the vacuum.

11. The method of claim 7 further comprising the step of providing a pressure transducer for converting pressure data to electronic data.

12. The method of claim 11 further comprising the step of providing a data processor for manipulating the electronic data.

13. The method of claim 12 further comprising the step of displaying the collected test data to illustrate ink flowability.

14. An apparatus for testing ink flowability, the apparatus comprising:

a cartridge having a printhead with a plurality of nozzles;

a pump communicating with the nozzles and applying a predetermined
vacuum to simulate flow rate through the printhead;

a pressure transducer monitoring the pressure in the cartridge as fluid is displaced through the nozzles; and

a mask for selectively covering a predetermined portion of the printhead so that only selected nozzles communicate with the pump.

15. The apparatus of claim 14 further comprising a data processor for receiving data from the pressure transducer.

16. The apparatus of claim 14 further comprising a clamp block that receives the cartridge printhead.

17. The apparatus of claim 16 wherein the clamp block includes a recess that generally conforms to the printhead.

18. The apparatus of claim 17 wherein the mask is sealingly clamped to the printhead.

19. The apparatus of claim 14 further comprising additional masks having openings at different locations to test ink flow through different nozzles on the printhead.

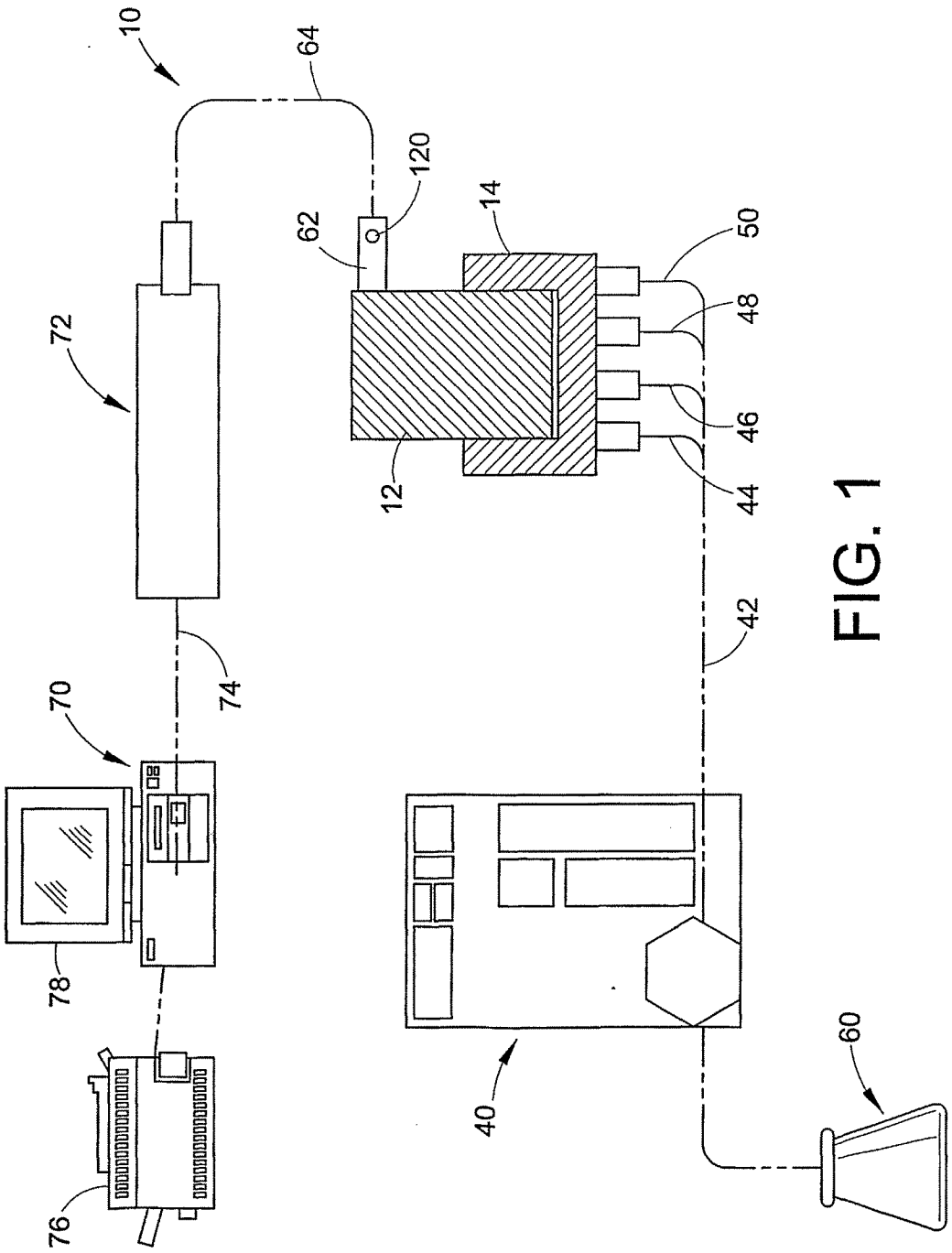

FIG. 1

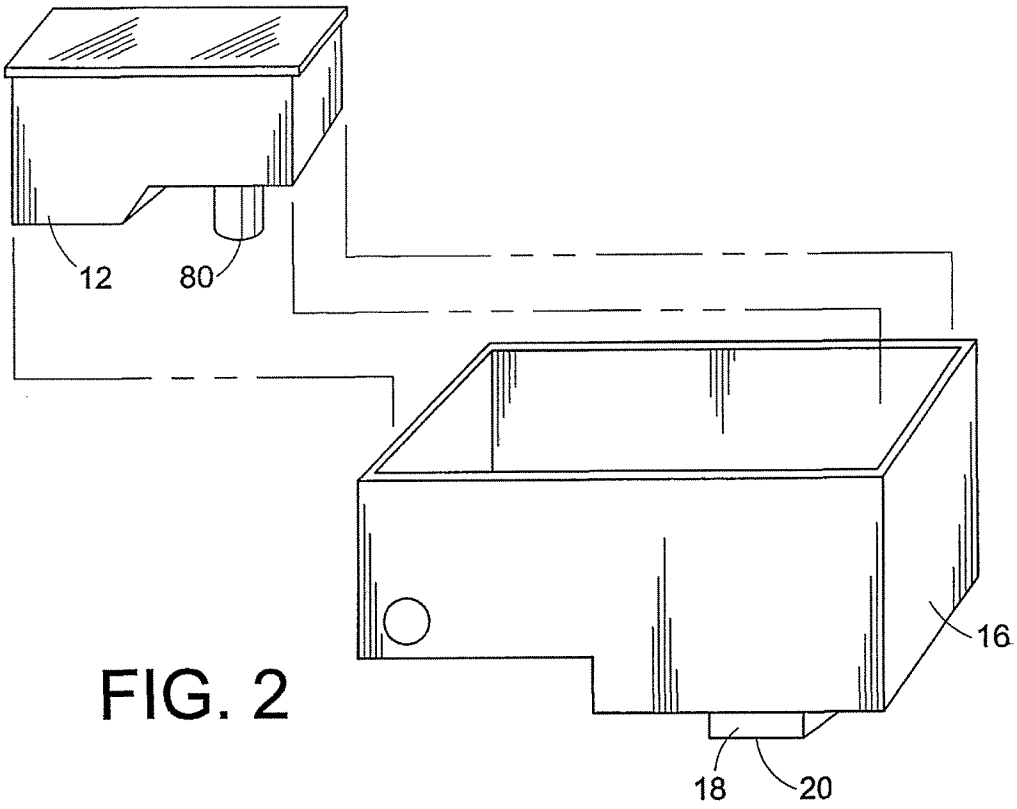

FIG. 2

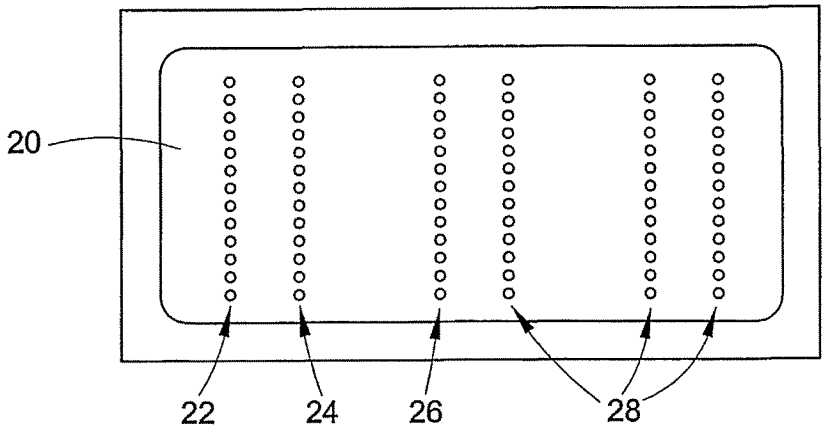

FIG. 3

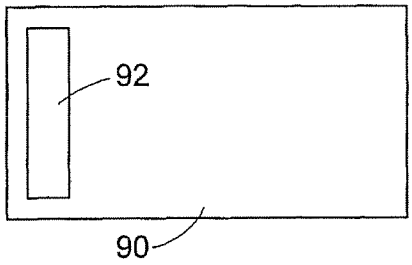

FIG. 4

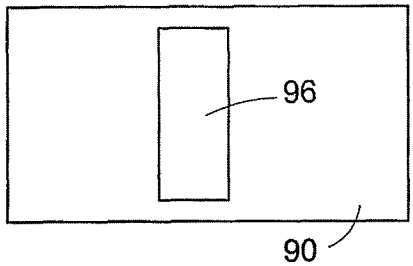

FIG. 5

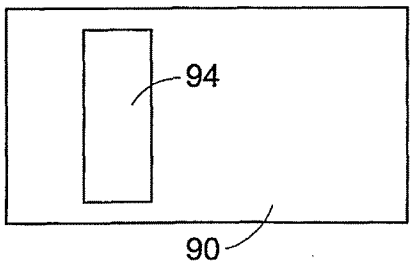

FIG. 6

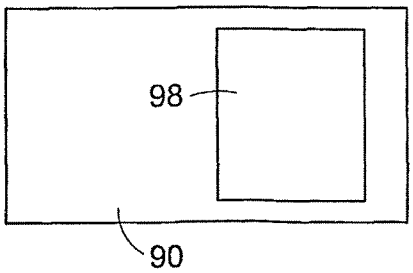

FIG. 7

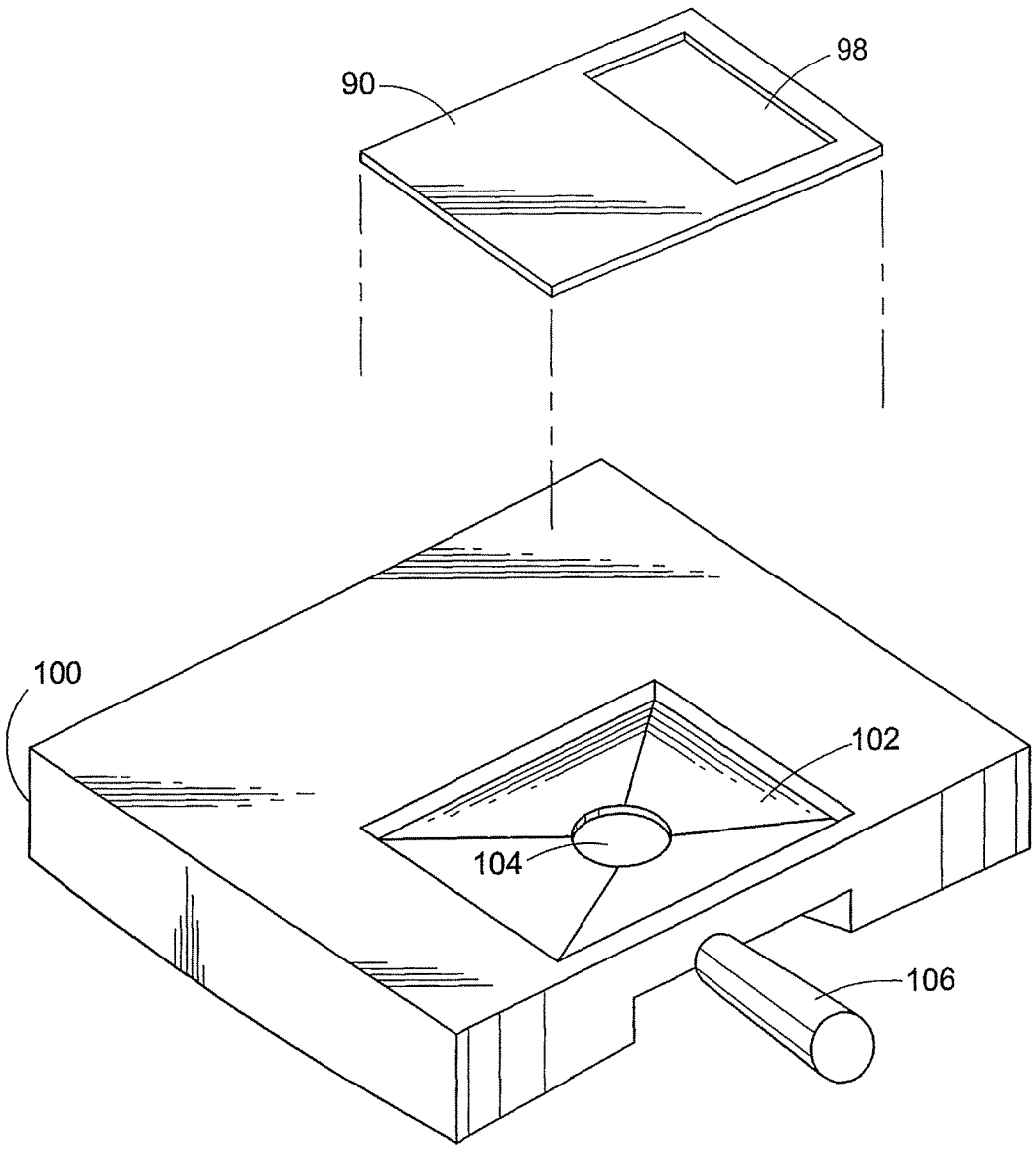

FIG. 8

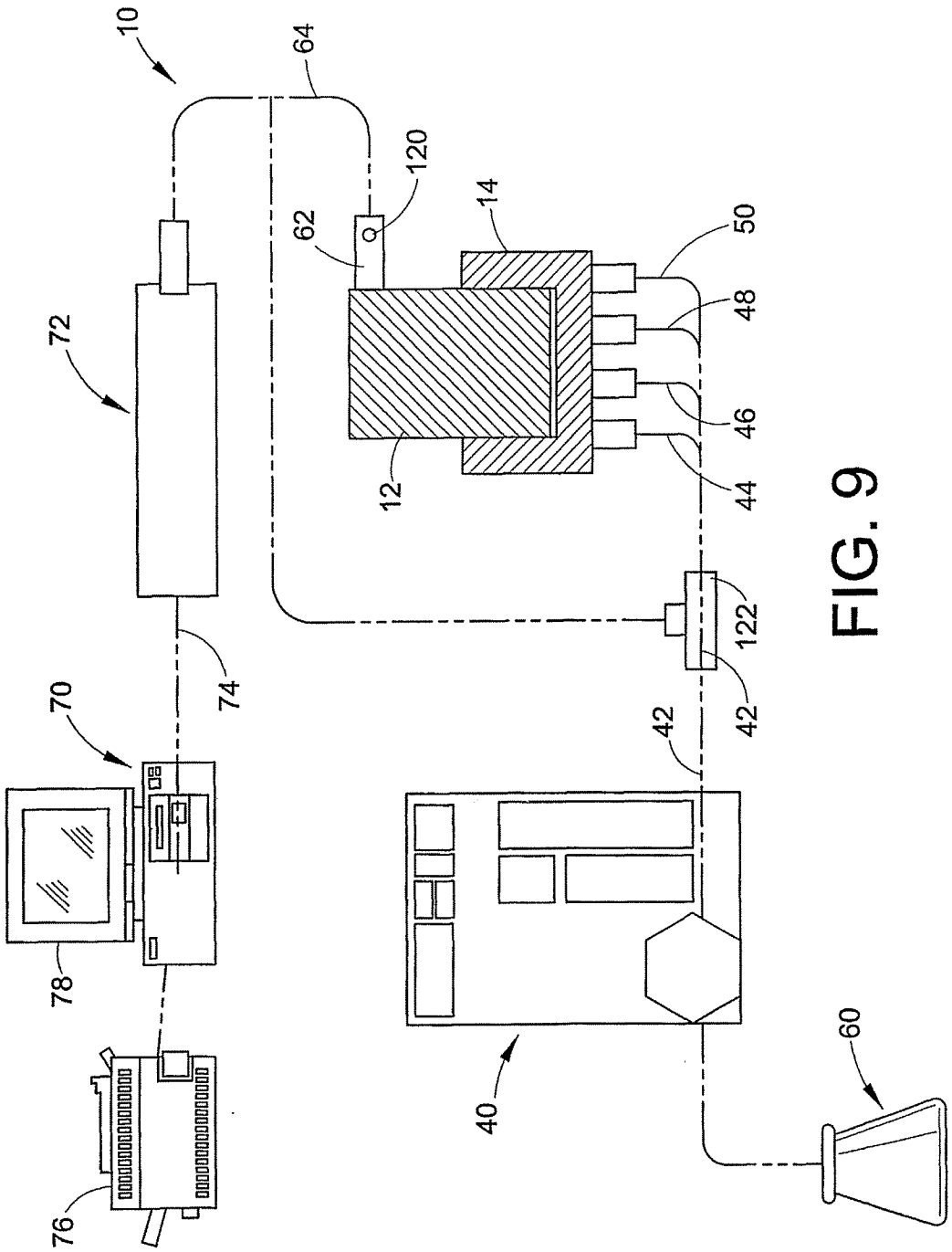

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/31276

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : B41J 29/393
US CL : 347/19
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 347/19, 14, 17, 23, 30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 6,260,941 B1 (SU et al.) 17 July 2001 (17.07.2001), col. 8, lines 40-57, col. 12, line 35 - col. 13, line 29, Figs. 3, 11.	1-19
Y	US 5,528,269 A (DROGO et al.) 18 June 1996 (18.06.1996), col. 2, line 53 - col. 3, line 8.	1-19
A	US 5,917,515 A (NONOYAMA et al.) 29 June 1999 (29.06.1999), col. 9, lines 47-62.	1-19
A	US 5,382,969 A (MOCHIZUKI et al.) 17 January 1995 (17.01.1995), col. 7, lines 57-68.	1-19
A	US 5,248,999 A (MOCHIZUKI et al.) 28 September 1993 (28.09.1993), col. 2, lines 29-38.	1-19

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